136. Use of Magnetic Resonance Angiography to Better Define the Supraclavicular Lymph Node Flap

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**Background:** The supraclavicular (SC) LN flap is an ideal flap for vascularized lymph node transfer, however it is not commonly used due to concern over its reliable anatomy and sufficient number of lymph nodes. We use magnetic resonance angiography (MRA) to delineate number, size, and location of SC lymph nodes in reference to the transverse cervical artery (TCA).

**Methods:** A retrospective review of right neck MRAs performed at our institution from January through September 2014 was performed. 30 studies met inclusion criteria. The right TCA was identified and the diameter at its origin measured. Size and distance of SC nodes in three dimensions in relation to the TCA origin were measured.

**Results:** A total of 142 lymph nodes were identified with an average of 4.7±2.2 nodes per patient and mean size of 5.3±2mm. Average diameter at the TCA origin measured 2.7±0.8mm. With respect to the TCA origin, 100% lymph nodes were lateral, 96% were superior, and 78% were posterior. Average distance from the TCA origin was 37±13 mm, with 19.2±11.8 mm superior, 27.7±11.3mm lateral, and 23.1±11.8mm posterior to TCA origin. 23% of patients had a separate origin of the TCA from the subclavian artery.

**Conclusion:** The results from this study demonstrate sufficient and consistent number of nodes and better delineate the anatomy of the SCLN flap as well as provide useful guidelines for identifying targeted nodes more efficiently.
Figure 1: In each MRA study, the transverse cervical artery was identified (yellow arrow) and used as a landmark to determine its relationship to the supraclavicular lymph nodes. The diameter at its origin was measured.

Figure 2: Right supraclavicular lymph nodes were identified as low signal intensity foci (yellow arrows) in a background of hyperintense fat. Distance of each node from the TCA origin was measured in the X, Y, Z dimensions.
137. Combined Deep Inferior Epigastric Perforator Flap with Gastroepiploic Lymph Node Transfer in a Single Operation

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**Background:** Treatment of post-mastectomy upper extremity lymphedema with simultaneous autologous breast reconstruction and vascularized lymph node transfer (VLNT) has been previously described using the deep inferior epigastric perforator (DIEP) flap with groin lymph nodes transferred to the axilla. Because the groin donor site can cause iatrogenic lymphedema, we propose an alternative approach for combined autologous breast reconstruction and VLNT. Herein, we describe the technique and post-operative outcomes of combined DIEP flap breast reconstruction with gastroepiploic lymph node transfer (GELNT) in a single operation to treat upper extremity lymphedema following mastectomy.

**Methods:** This study included patients treated by a single surgeon for post-mastectomy upper extremity lymphedema with simultaneous DIEP flap breast reconstruction and GELNT. All patients underwent pre-operative and post-operative volumetric measurements of the affected upper extremity above and below the elbow, and above the wrist. Post-operative outcomes and complications were analyzed.

The DIEP flaps were dissected in standard fashion and anastomosis to the internal mammary vessels was performed. A 7cm midline epigastric laparotomy incision was made once the abdominal flaps were dissected to the level of the xiphoid process. Gastroepiploic lymph nodes were identified using indocyanine green (ICG) lymphangiography. Starting at the scissura gastrica, dissection was carried along the greater curvature of the stomach to isolate the gastroepiploic vessels. The GELN flap was then placed into the axilla, forearm, or wrist of the affected extremity. Identification of the lymph nodes using ICG permitted division of the flap and bi-level VLNT from single donor site.

**Results:** Five patients underwent combined DIEP flaps with GELNT between 2014-2015. Average age was 55 years old. There were no significant differences in patient comorbidities. Two patients received bi-level GELNT to the axilla and wrist of the affected extremity, and three patients underwent single level transfer. Average volumetric reduction rate was 28.72% at 1 month, 66.34% at 3 months. There were no GELN flap donor site post-operative complications.

**Conclusion:** Combined autologous breast reconstruction with DIEP flap and GELNT is an excellent alternative approach for combined breast reconstruction and treatment of upper extremity lymphedema. Compared to currently described techniques, this approach allows VLNT to upper extremity locations other than the axilla and for free contouring of the DIEP flap for breast reconstruction.
Background: Vascularized lymph node transfer (VLNT) is a surgical treatment for lymphedema. Donor sites include the groin, axilla, submental and supraclavicular areas. Each site has significant disadvantages. We propose the jejunal mesentery as a novel donor site for VLNT. The purpose of this study was to describe the anatomy of the jejunal mesentery and to report our outcomes on the first jejunal mesenteric VLNT’s performed.

Methods: Cadaveric anatomic study analyzing jejunal lymph nodes (LNs) and outcomes from the first eleven clinical patients. Cadaveric study: the jejunum was divided into three 33-inch segments: proximal, middle and distal. LNs were identified by transillumination and palpation. Total LNs and LNs peripheral to the major vascular arcade were counted. Clinically, the jejunal mesenteric vascularized LN flap was harvested from the periphery of the proximal jejunum and transferred for treatment of lymphedema. Etiology of lymphedema, surgical details, and results including subjective and objective data were analyzed for each patient.

Results: In 5 cadavers, the average number of total LNs and peripheral LNs were identified in the proximal, middle and distal segments of jejunum. Total counted were 19.2/13.8/9.6 respectively (SD7.0/4.4/1.1), of those 10.4/6.8/3.4 (SD3.6/2.3/2.6) were in the periphery. There were significantly more total and peripheral lymph nodes in the proximal segment compared to the middle and distal segments, p=0.027 and p=0.008 respectively. The jejunal VLNT was used in 11 patients for treatment of upper (4) or lower (7) extremity lymphedema. Average age at presentation was 57.5(+/-5.1), average BMI was 32.1(+/-6.3), average duration of symptoms was 117.8(+/-79.4) months, and average follow up was 7.8(+/-4.5) months (range 1-15). Etiology of lymphedema was treatment for malignancy in 10 patients and defibrillator placement in 1 patient. All ten patients treated for malignancy had lymph node dissections, and three had radiation. The jejunal mesenteric LN flap contained at least three lymph nodes in 6 patients, four in 4 patients and five in 1 patient. One flap loss and no donor site complications were observed. Of the ten patients with viable flaps, six patients had pre-operative measurements. Of those six patients, five had subjective improvement and four had objective improvement in lymphedema.

Conclusion: The jejunal VLNT is an excellent option for lymphedema treatment as there is no risk of donor site lymphedema or nerve damage and the scar is easily concealed. Harvest from the periphery of the proximal jejunum is optimal. Improvement from lymphedema can be expected in a majority of patients.
The Use of Pedicled and Free Latissimus Dorsi Flaps with Lateral Thoracic Lymph Nodes for the Treatment of Lymphedema

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Purpose

Lymphedema is a chronic and debilitating condition that affects over 250 million people worldwide. An increasingly popular surgical treatment for lymphedema consists of vascularized lymph node transfer (VLNT). Recently, authors have described case reports and small series using a latissimus dorsi (LD) flap in conjunction with the lateral thoracic lymph nodes to treat lymphedema. Here, we present our experience with both free and pedicled LD-based VLNT for the treatment of lymphedema, which to our knowledge is the largest reported series to date.

Methods

An IRB-approved review was performed of patients who underwent VLNT using LD myocutaneous flaps harvested in conjunction with thoracic lymph nodes at our institution from May 2014 to September 2015. Both pedicled and free flaps were included for analysis. Thoracic lymph nodes were limited to level I nodes (inferior to the lateral border of the pectoralis minor muscle) to avoid damaging the lymphatics draining the arm. Collected information included patient characteristics and surgical outcomes. Quantitative (e.g., volume differential reduction) and qualitative (e.g., Lymphedema Life Impact Scale [LLIS]) measures of lymphedema were assessed.

Results

A consecutive series of 11 patients (9 females; mean age 52 years, range 44-61) underwent thoracic VLNT using latissimus dorsi myocutaneous flaps for lymphedema. Eight (73%) pedicled flaps were used for the treatment of upper extremity lymphedema and 3 (27%) free flaps were used to treat lower extremity lymphedema. With a mean follow-up of 6.7 months (range, 3-12 months), 10 patients (91%) reported symptomatic improvement after surgery. The mean preoperative volume differential between the normal and affected limb was 35% (range, 3-87%). The volume differential reduction was 48%, 28%, and 46% at 3, 6, and 12 months, respectively. The average LLIS score improved from 46.8 preoperatively to 39 at 3 months and 38.6 at 12 months postoperatively. There was one case of flap loss at postoperative day 10. Other complications included arterial thrombus requiring anastomotic revision (n=1), donor site infection requiring antibiotics (n=1), and donor site seroma managed conservatively (n=1).

Conclusion

Our series, which is the largest reported series to date of thoracic VLNT using LD-based flaps, demonstrates that this is a viable option to treat upper and lower extremity lymphedema in selected patients. Further research that would include a larger sample size and longer follow-up is warranted to more robustly study the strengths and limitations of LD-based VLNT in the treatment of lymphedema.
140. Is Surgical Treatment of Upper Limb Lymphedema Cost Effective? A Cost Utility Analysis

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Background: Breast-cancer related lymphedema (BRCL) has been reported to occur in 4-60% of patients following oncologic resection with significantly effects on patient quality of life yet it remains poorly described. Non-surgical methods of have been the mainstay of treatment including complex decongestive therapy, however, more recent surgical treatments have been described which involve lymph node transfer, lymphovenous bypass, and liposuction. The added health costs, complications, and quality of life for these patients are under-reported and largely misunderstood. We sought to perform the first cost effectiveness analysis comparing surgical and non-surgical treatments for patients with existing upper extremity lymphedema looking at cost, quality of life, and health outcomes.

Methods: We performed a thorough literature review using the MEDLINE, EMBASE, and COCHRANE databases to identify articles describing the rate, complications (cellulitis, lymphangitis, mental health), and cost of lymphedema in patient cohorts undergoing either surgical or non-surgical treatment. Utility estimates were obtained using a novel lymphedema-specific questionnaire from an expert panel of breast and plastic surgeons and compared to the literature. A cost effectiveness analysis was conducted using these values to compare non-surgical and surgical treatment of upper extremity lymphedema.

Results: 25 articles fit the inclusion criteria. The average rate of functional improvement with surgery was 89%. Among the 11% with persistent lymphedema, 14% had cellulitis, 15% with lymphangitis, and 25% with mental health issues. The average rate of functional improvement without surgery was 40%. Among the 60% with persistent lymphedema, 14% had recurrent cellulitis, 15% had recurrent lymphangitis, and 25% had mental health issues. Surgical treatment of lymphedema was cost effective with an incremental cost utility ratio (ICUR) of $4,867.03/QALY. Sensitivity analysis confirmed the robustness of our conclusions.

Conclusion: Surgical treatment of lymphedema is cost effective relative to non-surgical methods of treatment due to the significant improvement in function and quality of life. Surgical methods of reconstruction should always be considered in suitable patients in the hands of appropriately trained surgeons.

Figure 1. Cost Effectiveness Analysis showing that surgical treatment of lymphedema is cost effective relative to non-surgical treatment using a $50,000/QALY Willingness-to-pay (WTP) threshold. QALY, Quality-adjusted life year.
Figure 1. Cost Effectiveness Analysis showing that surgical treatment of lymphedema is cost effective relative to non-surgical treatment using a $50,000/QALY Willingness-to-pay (WTP) threshold. QALY, Quality-adjusted life year.
Safety first in vascularized lymph node transfer (VLNT) – Decreasing donor site morbidity with lessons learned during 10 year experience with VLNT

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Background: Vascularized lymph node transfer (VLNT) has been described as a treatment for breast cancer-related lymphedema. Its efficacy on treating lymphedema and beneficiary impact on quality of life is proven.

Harvesting of the groin lymph node flap raises concerns of donor site morbidity. In particular the potential risk of creating a secondary lymphedema of the donor site is a concern when harvesting a vascularized lymph node flap. Secondary lymphedema is caused by harvesting of, or damage to, lymph nodes and lymph vessels responsible for drainage of the lower limb during flap dissection. Other donor site complications include seroma and wound dehiscence.

Our study has been designed to investigate donor site morbidity after VLNT. The second aim was to describe the strategy developed during 10 year experience with VLNT in our center in order to decrease donor site morbidity.

Patients & Methods: A retrospective review of the donor site complications in VLNT in a single center from 2006 to March 2016 was performed. 65 vascularized groin lymphnode transfers with or without simultaneous breast reconstruction and/or lymphovenous anastomosis (LVA) were performed in the same number of women suffering from upper limb lymphedema after breast cancer treatment. The patients medical histories were also reviewed for risk factors for donor site complications: body mass index, smoking and age.

Several techniques to avoid donor site complications and warrant successful transfer of the groin lymph node flap have been described. The strategy used in our centre from 2012 to decrease donor complications has as key points for harvesting: perform less flap undermining, avoid harvesting of lymph nodes medial to the superficial inferior epigastric vessels, inject patent blue dye intradermal at the high upper thigh and avoid harvesting the upper thigh draining lymph node, and clip big afferent lymphatic vessels. For donor site closure the strategy includes the use of mattress sutures, fibrin glue, and deepithelialisation of the flap in order to obliterate dead space.

Results: Seroma was the most common complication (2006-2016: 35%). After implementation of the described harvesting and closure strategy seroma rate decreased significantly to 8% (2012-2016).

Wound dehiscence at the donorsite occured in 24,2%. In the majority of cases this dehiscence was superficial and could be managed successfully with conservative measures only.

Lymphedema of the afferent limb didn't occur.

Conclusion: Vascularized lymph node transfer is an efficacious treatment for lymphedema. Donor site morbidity is a major concern. Implementation of a donor site complications minimizing strategy reduces seroma formation.
142. Effective and Efficient Lymphaticovenular Anastomosis Using Preoperative Ultrasonographic Imaging of Lymphatic Vessel; Retrospective Study in 55 Lower Extremity Lymphedema Patients

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**Background:** Identification of functional lymphatic vessels and determination of the location of lymphatic vessels are important for lymphaticovenular anastomosis. Indocyanine green lymphography is useful for that purpose, but it cannot show lymphatic flow in the deep layer of subcutaneous tissue, or one that is masked beneath dermal backflow patterns. The authors established a new detection technique of lymphatic vessel for lymphedema patients using ultrasound in the site where dermal backflow pattern was shown in indocyanine green lymphography or indocyanine green is not able to be used (Fig. 1&2).

**Methods:** 55 patients with secondary lower extremity lymphedema patients who underwent lymphaticovenular anastomosis were classified into two groups, ultrasound-detection-of-lymphatic group (n=29) and non-ultrasound-detection-of-lymphatic group (n=26), and assessed. Sensitivity and Specificity of this new technique were evaluated in the ultrasound-detection-of-lymphatic group. Intraoperative findings, required time for dissecting lymphatic vessels and venules, length of skin incision and postoperative lymphedematous volume reduction were compared between two groups.

**Results:** Lymphatic vessels were detected in all incisions in both groups. The lymphaticovenular anastomoses resulted in 232 anastomoses in ultrasound-detection-of-lymphatic group and 210 anastomoses in non-ultrasound-detection-of-lymphatic group. The sensitivity and specificity of ultrasound detection technique of lymphatic vessels in ultrasound-detection-of-lymphatic group were 93.4% and 87.2%, respectively (Table 1). The diameter of lymphatic vessels in the ultrasound-detection-of-lymphatic group was significantly larger than in the non-ultrasound-detection-of-lymphatic group (0.66 ± 0.18 versus 0.45 ± 0.20; p < 0.05). The required time for dissecting lymphatics and venules in the ultrasound-detection-of-lymphatic group was less than in the non-ultrasound-detection-of-lymphatic group (9.2 ± 1.7 versus 14.7 ± 2.4; p < 0.05). Reduction of the lower extremity lymphedema index was significantly greater in the ultrasound-detection-of-lymphatic group than in the non-ultrasound-detection-of-lymphatic group (26.7 ± 13.6 versus 7.8 ± 11.3; p < 0.05) (Table 2, Fig. 3&4).

**Conclusions:** Ultrasound-guided detection of lymphatic vessels for lymphedema was performed with high precision, even in rich fatty tissue and deep layer (Fig. 5). The most important things for detection of lymphatic vessels are distinction from blood vessels and nerves (Table 3). This technique enabled lymphaticovenular anastomosis efficient and effective, and may aid lymphatic microsurgery for lymphedema in the future.
Table 1.

<table>
<thead>
<tr>
<th>Number of detected lymphatic vessels in ultrasound-detection-of-lymphatic group</th>
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<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>US</td>
</tr>
<tr>
<td>Intraoperative finding of lymphatic vessels</td>
</tr>
<tr>
<td>+*</td>
</tr>
<tr>
<td>-**</td>
</tr>
</tbody>
</table>

US, Ultrasonography

* "+" denotes a state where a lymphatic vessel was found with ultrasonography or intraoperative direct observation.

* * "-" denotes a state where a lymphatic vessel was not found with ultrasonography or intraoperative direct observation.

Table 2.

<table>
<thead>
<tr>
<th>Comparison between Cases of the Ultrasound-detection-of-lymphatic group and the Non-ultrasound-detection-of-lymphatic group</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>Ultrasound-detection-of-lymphatic group (n = 29)</td>
</tr>
<tr>
<td>Non-ultrasound-detection-of-lymphatic group (n = 26)</td>
</tr>
<tr>
<td>p</td>
</tr>
<tr>
<td>Age, yr</td>
</tr>
<tr>
<td>Body Mass Index, kg/m²</td>
</tr>
<tr>
<td>Duration of edema, yr</td>
</tr>
<tr>
<td>No. of LVAs per patient</td>
</tr>
<tr>
<td>Diameter of Lymphatic vessel, mm</td>
</tr>
<tr>
<td>Diameter of venule, mm</td>
</tr>
<tr>
<td>Required time for dissecting lymphatic vessels and venules, min</td>
</tr>
<tr>
<td>Length of skin incision, cm</td>
</tr>
<tr>
<td>Change in LEL index</td>
</tr>
</tbody>
</table>

LVAs, lymphaticovenular anastomoses; LEL, lower extremity lymphedema

*p < 0.05
Figure 3.
Table 3.

<table>
<thead>
<tr>
<th>Characteristics of lymphatic vessel, blood vessel and nerve</th>
<th>Shape</th>
<th>Echogenic texture</th>
<th>Color Doppler mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lymphatic vessel</td>
<td>Spicular misshapen</td>
<td>Hypoechoic</td>
<td>Not colored</td>
</tr>
<tr>
<td>Blood vessel</td>
<td>Round</td>
<td>Hypoechoic</td>
<td>Colored / Not colored</td>
</tr>
<tr>
<td>Nerve</td>
<td>Honey comb</td>
<td>Bright with hypoechoic fascicles</td>
<td>Not colored</td>
</tr>
<tr>
<td></td>
<td>Oval (Superficial Nerve)</td>
<td>One hypoechoic fascicle (Superficial Nerve)</td>
<td></td>
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</tbody>
</table>
143. Vectra 3D Imaging for Quantitative Volumetric Analysis of the Upper Limb: A Feasibility Study for Tracking Outcomes of Lymphedema Treatment

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BACKGROUND:
Limb volume measurements are considered the gold standard in evaluating outcomes in upper limb lymphedema. Despite this fact, most clinicians opt for simpler, quicker methods for objective assessment. Three-dimensional imaging utilizing the Vectra Imaging system may allow for quick and accurate volumetric upper limb assessment. The aim of this study is to determine if the Vectra 3D imaging system can feasibly achieve accurate volume measurements of the upper limb.

METHODS:
A feasibility study was conducted with twelve healthy volunteers. The Vectra 3D imaging system and software (Canfield Scientific, Inc, Fairfield, New Jersey) were used to generate images and calculate volumes. The area included in imaging included the fist, forearm, and upper arm. Because circumference measurements cannot accurately determine hand volume, volume measurements were calculated for the segment of the arm from the ulnar styloid to 15 cm proximal to the olecranon using the Vectra 3D and standard tape circumference measurements (every 4 cm). A truncated cone formula was used to calculate volumes from standard tape measurements for comparison. A comparative analysis was performed using linear regression.

RESULTS:
Twelve volunteers were enrolled for volumetric comparison. The average limb volume calculated for Vectra 3D and tape measurements were 2029 cc and 2030 cc, respectively. The Vectra 3D provides precise volume measurements (average standard deviation +/- 1.0%). Measurements from the Vectra 3D showed strong correlation with circumference measurements (R2 = 0.999) as well as good agreement, with the mean difference between measurement techniques being 1.0 ± 0.8%. (Figure 1). Arm volumes measured ranged from 1250 cc to 3300 cc, demonstrating the ability of three-dimensional imaging to accurately measure a variety of limb sizes, essential for its potential use in tracking lymphedema treatment.
Figure 1: Comparison between Vectra 3D and circumferential measurements of limb volume (dashed line, y=x). Error bars represent the standard deviation between Vectra 3D measurements.

CONCLUSION:
The Vectra 3D provides accurate and precise data for measurements of the forearm and upper arm comparable to the most commonly used technique to estimate limb volume (tape measurement). Along with its ability to incorporate hand volumes, the Vectra 3D imaging system has the added benefits of time efficiency, ease of use, accurate reproducibility, and likely greater accuracy.
**144. A Head to Head Comparison Among Donor Site Morbidity After Vascularized Lymph Node Transfer: Pearls and Pitfalls of A 6-Year Single Center Experience**

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*A Head to Head Comparison Among Donor Site Morbidity After Vascularized Lymph Node Transfer: Pearls and Pitfalls of A 6-Year Single Center Experience*

**Introduction:** Between 2010-2016, 110 patients with extremity lymphedema underwent lymph node flap (LNF) transfer: groin (G-LNF=20), supraclavicular (SC-LNF=54) and right gastroepiploic (RGE-LNF=36) open and laparoscopic approach. Herein, we discuss the pearls and pitfalls for LNF harvest and compare donor-site morbidity and complications after LNF transfer. Lymphatic leakage: G-LNF(n=1) and SC-LNF(n=1) and one hematoma: SC-LNF were found. Laparoscopic harvest of the RGE-LNF reduces donor-site morbidity. However, surgeons experience is imperative to minimize donor site morbidity and complications.

**Background:** Lymph node flap (LNF) transfer has shown promising results in the treatment of extremity lymphedema. However, there are still some concerns regarding donor site morbidity following LNF harvest. The aim of this study is to discuss the pearls and pitfalls for flap harvest and to compare donor site morbidity and complications after LNF transfer with the most common flaps used in our unit.

**Materials and Methods:** Between 2010 and 2016, 160 patients with extremity lymphedema underwent LNF transfer. In order to be included in this study, patients required at least 2-years of follow-up.

**Results:** A total of 110 patients met inclusion criteria (41 patients with upper and 69 patients with lower extremity lymphedema). The most common LNF’s used in our unit: groin (G-LNF), supraclavicular (SC-LNF) and right gastroepiploic (RGE-LNF) open and laparoscopic approach. The total number of LNF transfer was: groin G-LNF (n=20), SC-LNF (n=54), RGE-LNF open (n=19) and RGE-LNF laparoscopic (n=17). The mean operative time for flap harvest was: (92.5 ± 12.7), (78.7 ± 24.9), (92.6 ± 9.8), and (33.1 ± 4.4) minutes for G-LNF, SCLNF, open RGE-LNF and laparoscopic RGE-LNF respectively. In terms of complications, two donor site lymphatic leakage after G-LNF(n=1) and SC-LNF(n=1) were found. One patient required re-exploration due to a hematoma after SC-LNF transfer.

**Conclusion:** Correct flap selection and surgeon experience are imperative in order to reduce donor site morbidity and complications. Based on our experience, the RGE-LNF transfer reduces donor site morbidity, hospital length of stay and operative time specially when harvested laparoscopically.
INTRODUCTION: Lymph node flap (LNF) transfer has shown promising results and its becoming one of the mainstay treatment options for extremity lymphedema. However, there are concerns regarding donor site morbidity following LNF harvest. Also, some observations have been made with regards of the effect of LNF on areas of the extremity away from the transferred flap. Herein, we describe the extended right gastroepiploic lymph node flap (RGE-LNF) via laparoscopic approach with a double level flap inset for patients with upper and lower limb lymphedema.

MATERIALS AND METHODS: Between 2012 and 2015, patients with grade II and III upper or lower extremity lymphedema were selected for LNF transfer. Preoperative and postoperative limb circumference and lymphoscintigraphy were obtained. All patients underwent laparoscopic harvest of the extended RGE-LNF. In all cases, a double inset was performed at a distal and mid-limb level of the affected limb by dissecting a single flap in two. In addition, etiology of lymphedema, OR time and complications were analyzed.

RESULTS: A total of 7 patients were analyzed. The etiology was due to mastectomy and axillary lymph node dissection for breast cancer (n=4) and after hysterectomy and radiotherapy for gynecological cancer (n=3). The survival rate of the flaps after microsurgical transfer was 100%. The average operating time for flap harvest was 37 ± 4.7 minutes; The average time for flap preparation was 8.7 ± 0.8 minutes. The average total operating time including harvest and insets was 245 minutes. The average follow-up period was 14 months. The mean circumference reduction rate of the lymphedematous limb during follow-up was 43.4 ± 4.0% (range, 38.3% to 48.9%). Postoperative lymphoscintigraphy showed improvement of the lymph flow on the affected limb in all cases. No donor-site morbidity was encountered during the follow-up period.

CONCLUSION: The laparoscopic harvest of the extended RGE-LNF with a double level flap inset has been showing promising results. Due to the reduction of overall limb volume and symptomatic improvement, this approach may be a new potential treatment option for patients with extremity lymphedema. In addition, minimally invasive approach achieved reduction in donor site morbidity.
146. Multiple Lymphatic Transfer for Severe Leg Lymphedema

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Multiple lymphatic transfer for severe leg lymphedema

Severe lymphedema causes skin sclerosis and recurrent cellulitis and sometimes leads to death. Recently lymph node or lymphatic transfer has been developed for such a severe lymphedema as an effective method. But the problem is that single lymph node or lymphatic flap cannot treat a bilateral lymphedema or severe lymphedema of several portion. This time we report a new concept of "Multiple lymphatic transfer".

From 2006 to 2014, we performed 125 cases of combined surgical treatment which include lymphatic(lymph node) transfer. The age of patient was 13 to 78. 23 cases were primary leg lymphedema and 102 cases were secondary leg lymphedema.

As a surgical procedure, We select lateral thoracic area as a donor site. We elevate multiple lymphatic flaps from one donor site at one operation. Lateral thoracic artery perforator, thoracodorsal artery perforator, and inter costal artery lateral perforator were used as a feeding vessel. Also sometimes we made multiple lymphatic flaps by dividing one flap into several part along the vessel(Fig.1,2,3).

Recipient site were sever edema portions of the patients. Recipient vessel were perforator of anterior tibia artery, dorsalis pedis artery, lateral femoral artery, and superficial circumflex iliac artery. Perforator to perforator anastomosis was done using supermicro technique.

Follow up period is four month to 8 years. Among 125 cases, 60% show improvement (Fig.4), 30% were constant and 10% become worse. The more flaps we transfer the better the result tend to be.

The result shows lymphatic transfer is effective for severe lymphedema. Lateral thoracic area has many source vessels such as lateral thoracic artery, thoracodorsal artery and intercostal artery perforator. It enables us to elevate multiple flaps from one donor site. Also Using dividing technique we developed, we can make the more multiple flaps (Fig.5). This new concept enables us to treat several portion at one operation and treat bilateral severe lymphedema.

Using this concept, anastomosis become perforator-to-perforator anastomosis. So it demands supermicrosurgical technique.

Several years ago, simple LVA is changed to multiple LVA. In the same way, lymphatic transfer (LT) will become "multiple LT".
147. Lymph Node Flap Transfer and Modified Charles Procedure for Advanced Lower Limb Lymphedema

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**INTRODUCTION:** Lymph node flap transfer (LNFT) is becoming a popular physiologic approach for treating lower limb lymphedema. However, in chronic and severe cases, the Charles’ procedure allows radical reduction of the lymphatic load of the limb and should only be considered when other procedures are not feasible due to its potential complications as infection and poor cosmesis. The aim of this study is to present our experience combining tissue transfer procedures (LNFT) and excisional operations (the modified Charles procedure) for the surgical treatment of advanced lower limb lymphedema.

**MATERIALS AND METHODS:** From July 2010 to May 2015, 45 patients who were diagnosed and treated for advanced lower limb lymphedema with LNFT and a modified Charles procedure were analyzed. In addition, demographics, circumferential limb measurements, lymphoscintigraphy, skin tonicity and postoperative complications were recorded. The reduction rate was describe by the percentage of improvement on skin tonicity and limb circumference. Postoperative follow-up was performed every 3 months during the first year and subsequently every 6 months.

**RESULTS:** After a 4-year follow-up, a total of 45 patients were analyzed. Twelve were male and thirty-three were female. During the follow-up period, all patients exhibited dramatic improvement in lower limb skin tonicity 35.0 % (range 12.5 to 78.0%) (p<0.05). In addition, the average reduction of limb circumference was 60.0% (range 40.0 to 90.0 %) (p<0.05). Moreover, the incidence of cellulitis exhibited a significant reduction in the postoperative period. Only five patients experienced superficial site infection after the operation, which was treated with antibiotics. No major complications were reported postoperatively. However, there were 6 patients with partial skin graft loss requiring re-grafting at the dorsum of the foot. Ten patients required revision and regrafting to improve the cosmesis. Postoperative lymphoscintigraphy displayed improved drainage of the affected limb. In addition, all patients were satisfied with their functional outcomes.

**CONCLUSION:** In cases of severe lower limb lymphedema, the combination of LNFT with the modified Charles procedure can be a good surgical option. This procedure may prevent some potential complications such as recurrence, infection, and aggravation of the disease due to the physiological properties of the transferred lymph nodes. However, further long-term studies are needed in order to rule out recurrence and long-term complications.
148. Minimized Lymphaticovenular Anastomosis (mini-LVA) for Lower Extremity Lymphedema Treated By the Superior-Edge-of-the-Knee Incision Method

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Background: The Superior-Edge-of-the-Knee Incision method for lymphaticovenular anastomosis (LVA) is reported to have a strong therapeutic effect in patients treated for lower extremity lymphedema (LEL) because lymph-to-venous flow at the anastomosis is enhanced by knee joint movement during normal walking. We try to minimize LVA operations as mini-LVA which is based on the Superior-Edge-of-the-Knee Incision method within two number of lymphaticovenular anastomoses (LVAs) creation.

Methods: The study involved eighteen patients with ISL stage 2 LEL characterized by stage 2–5 leg dermal backflow. Stage 2–3 dermal backflow patients were treated by a single LVA at the thigh via the Superior-Edge-of-the-Knee Incision method (single anastomosis group), and stage 4–5 dermal backflow patients were treated by two LVAs including LVA by the Superior-Edge-of-the-Knee Incision method and LVA around the ankle (two anastomoses group). The lymphatic vessel diameter and direction of flow were assessed intraoperatively, and reduction in lymphedema volume was assessed postoperatively.

Results: Ten patients with stage 2-3 dermal backflow treated by a single LVA resulted in 10 anastomoses, and eight patients with stage 4-5 dermal backflow treated by two LVAs resulted in 16 anastomoses. Mean diameter of the lymphatic vessel was 0.65 ± 0.17 mm (0.66 ± 0.09 and 0.65 ± 0.22 mm in the single anastomosis group and the two anastomoses group, respectively; p = 0.935). No venous reflux occurred in the single anastomosis group but 3 of 16 anastomoses showed venous reflux in the two anastomoses group. Mean follow up was 8.44 ± 4.36 months (8.10 ± 3.78 months and 8.88 ± 5.22 months for the single anastomosis group and the two anastomoses group, respectively; p = 0.731). The circumference of the affected limb was reduced in all patients. Mean reduction in the lower extremity lymphedema index was 16.083 ± 9.640 (19.323 ± 10.418 and 12.032 ± 7.237 in the single anastomosis group and the two anastomoses group, respectively; p = 0.100).

Discussion: Mini-LVA is characterized by reduced number of LVAs for the treatment of LEL, in which strong therapeutic effect of the Superior-Edge-of-the-Knee Incision method is considered as a key for new lymph-to-venous circulation. Although high volume reduction in stage 4-5 dermal backflow is still challenging, volume reduction in most of LEL patients, which is rarely obtained by LVAs without the Superior-Edge-of-the-Knee Incision method, can be achieved by only one or two LVAs. Mini-LVA has possibility to be a first-line surgical treatment for patients with LEL.
Indocyanine Green Lymphangiography Findings in Patients Who Do Not Meet Clinical Diagnostic Criteria for Lymphedema

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Introduction: The clinical diagnosis of lymphedema has been described as a limb volume difference of greater than 200 milliliters or greater than 10%. More recently, bioimpedance has been used to aid in the diagnosis of early lymphedema. However, there are patients who do not meet these thresholds but have significant lymphedema-related complaints as well as abnormal indocyanine green (ICG) lymphangiography. The purpose of this study was to evaluate lymphatic function using ICG in patients who do not meet clinical diagnostic criteria for lymphedema.

Methods: This is a retrospective study of patients with symptoms of secondary upper extremity lymphedema who were evaluated at MSK for surgical treatment from January 2015 to May 2016. Limb volumes were obtained using a perometer and the truncated cone formula based on serial 4 cm limb circumference measurements. Patients who did not meet clinical diagnostic criteria for lymphedema (limb volume < 200 ml or < 10% difference) were identified and their ICG studies were evaluated. Bioimpedance scores were available on 6 of these patients: 5 patients had scores within the normal reference range (-10 to +10) and 1 patient had a marginally elevated score of 11.6.

Results: 61 patients with upper extremity lymphedema presented to the MSK clinic from January 2015 – June 2016 seeking surgical intervention for lymphedema. A total of 8 of these patients (13.1%) had both a limb volume difference of < 200 ml and < 10%. Limb volume differences ranged from 16 to 168 ml (mean = 97.00, SD = 68.97) and percentage limb volume difference ranged from 0.58 to 8.59% (mean = 4.30%, SD = 3.62%). 5 of these patients had a limb volume difference of <5%. All 8 patients had abnormal ICG findings: 6 patients had a splash pattern, 1 patient had a stardust pattern, and 1 patient had a diffuse (advanced lymphatic disease) pattern. Bioimpedance scores were available on 6 of these patients: 5 patients had scores within the normal reference range (-10 to +10) and 1 patient had a marginally elevated score of 11.6.

Conclusion: The results in this study show there are significant abnormalities found in the lymphatic system in patients who do not meet criteria for the clinical diagnosis of lymphedema. Even in patients with nearly imperceptible swelling and a normal bioimpedance score, ICG changes in lymphatic function can be profound. As earlier surgical intervention is believed to be most effective, ICG lymphangiography may provide better insight into lymphatic function in patients with early lymphedema.
150. Lymphedema Induced Adipose Tissue Hypertrophy Limits Complete Limb Reduction Using Microsurgical Reconstruction

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BACKGROUND

In 1987 we noted an excess of adipose tissue in non-pitting lymphedematous tissue and recommended liposuction in order to remove the excess volume. Previous research had shown increased adipose tissue in intestinal segments in patients with Crohn's disease (fat wrapping) and that inflammation plays an important role in adipose tissue deposition. A functional inactivation of a single allele of the homebox gene Prox1 led to adult-onset obesity due to abnormal lymph leakage from mispatterned and ruptured lymphatic vessels. Adipogenesis in response to lymphatic fluid stasis is associated with a marked mononuclear cell inflammatory response and potently upregulates the expression of fat differentiation marker. Graves' ophthalmopathy, with excess intraorbital adipose tissue and exophthalmos, showed overexpression of adipocyte related immediate early genes, which play a role in both orbital inflammation and adipogenesis. We therefore wanted to analyze the excess volume in arm lymphedema following breast cancer treatment.

METHODS and RESULTS

1. Liposuction of non-pitting arm lymphedema showed 90% fat in the aspirate (n=120).
2. Investigation with Volume Rendering Computer Tomography (n=11) (Figure 1) and Dual-energy X-ray absorptiometry (n=18) (Figure 2) showed 81% and 73% more fat, respectively, in the non-pitting swollen arm preoperatively, followed by normalization at 3 months postoperatively.

![Fig. 1. Preop. VRCT-analysis showing an excess amount of adipose tissue in the left lymphedematous arm of 1316 ml when compared to the right unaffected arm.](image-url)
3. Several genes (ABCG1, ACTA2, SFRP2, TNC, PTX3, CPMX1) responsible for wound healing, fibrosis, fat metabolism and inflammation were upregulated in non-pitting arm lymphedema (n=10).

**CONCLUSION**

These results show that patients with chronic non-pitting lymphedema develop large amounts of subcutaneous adipose tissue, most probably due to chronic inflammation. This explains why these patients do not respond to conservative management or microsurgical reconstruction because the hypertrophy of the subcutaneous adipose tissue cannot be removed or reduced by these techniques. Liposuction completely removes the adipose volume excess and long-term outcome – 20 years for arms and 10 years for legs – shows no recurrence of the swelling (Figure 3-6).
Fig. 3. A 74-years-old woman with a non-pitting arm lymphedema of 15 years. Preoperative excess volume is 3090 ml and postoperative result.

Fig. 4. Mean postoperative excess volume reduction in 142 patients with postmastectomy arm lymphedema.

Fig. 5.
Preop. excess volume 14310 ml (left). 8 years postop (right)
Preop. excess volume 6630 ml (left). 2 years postop (right)
Fig. 6. Mean postoperative excess volume reduction in 56 patients with primary or secondary leg lymphedema.
Introduction
The lateral thoracic flap is a fasciocutaneous flap based off the lateral thoracic artery that can be harvested with neighboring lymph nodes for lymph node autotransplantation. Additionally, this flap can be designed as a sensate flap with adjacent intercostal cutaneous nerves. There is limited donor site morbidity with an inconspicuous scar. We present an anatomic study and clinical outcomes of this versatile flap.

Method
Anatomic studies of 30 lateral thoracic flaps in 15 cadavers were performed. A longitudinal incision was created at the anterior axillary line after subclavian artery injection of green dye. Intercostal perforators lateral to the pectoralis minor muscle were found to communicate with the more superficial lateral thoracic vessels within the deep subcutaneous tissue. The pedicle was dissected in a retrograde fashion and the relationship to zone I axillary lymph nodes was analyzed. The anatomic study was then translated to the clinical setting.

Results
The lateral thoracic vein was found midway between the anterior and mid-axillary line in all cadaveric dissections. Twenty-seven (90%) veins were accompanied by the artery, which ranged from 1.5 to 3.0 mm in caliber. Ten percent demonstrated rudimentary dispersing arterioles restricted to the adjacent lymph node basin. The pedicle arises directly from the subclavian artery and supplies the surrounding zone I axillary lymph nodes before coursing posteriorly to the intercostobrachial nerve. The flap dissection preserves the thoracodorsal nerve and artery and does not affect latissimus function. From February 2012 to May 2016, fifteen lateral thoracic lymphfasciocutaneous flaps were harvested, primarily for shoulder and axillary defects. One patient required a thoracodorsal artery perforator flap through the same incision for lack of a reliable lateral thoracic artery. All flaps survived with a mean follow up of 9 months. One patient with filariosis-induced lower limb lymphedema was treated with a free flap to the ankle. Lymph node function was assessed through lymphoscintigraphy and demonstrated radioactive contrast enhancement of lymphatic drainage. This corresponded to clinical volume reduction of the limb and fewer lymphangites episodes. Donor site morbidity was limited and there was no compromise of lymphatic drainage of the arm.

Conclusion
The lateral thoracic lymphfasciocutaneous flap is a reliable and reproducible flap. It preserves the function and vascularization of the latissimus dorsi muscle and may be used for lymphatic autotransplantation. The thoracodorsal artery perforator flap can be harvested through the same incision if the lateral thoracic artery is deemed insufficient.
Lymphaticovenular Anastomosis Will Save Stewart-Treves Syndrome Patients' Life

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(Background)
Lymphatic surgery has evolved in remarkable speed for these 25 years. The lymphaticovenular anastomosis (LVA) for lymphedema became popular. The lymphatic transfer for severe lymphedema refractory to LVA has developed. Over 1800 lymphedema cases had been treated in our department, and rare cases suffered from Stewart-Treves syndrome (STS). STS is a rare but life-threatening cutaneous lymphangiosarcoma which develops on chronic extremity lymphedema. The tumor grows drastically and typically metastasizes to the lungs and the chest wall. The patients are treated with radical surgery or systemic chemotherapy, however, the prognosis is miserable(Fig.1). In the follow-up of STS patients, we made very interesting discovery, so would like to show it.

(Materials and Method)
We report 3 cases with Stewart-Treves syndrome following secondary lower-extremity lymphedema, in whom lymphangiosarcoma disappeared(Fig.2,3). The cases are 54 years old female, 60 years old female, and 82 years old female. All of them had had LVA before STS developed. Of the 3 cases, lymphatic transfer was performed in 1 patient. Follow-up period is 2 to 9 years. All cases are still alive even though the vital prognosis of STS is quite poor, at most 1 year.

(Discussion)
The pathophysiology of Stewart-Treves syndrome is still controversial but disruption of local immune system may lead to the disease. LVA likely reactivates the local immune system in the lymphedematous extremities and this may have something to do with the favorable result of this study.

(Conclusion)
We experienced 3 cases with Stewart-Treves syndrome following secondary lower-extremity lymphedema, in whom lymphangiosarcoma disappeared after LVA. LVA might have a good effect on the prognosis of Stewart-Treves syndrome. LVA might have a great power not only to improve lymphedema but also to save patients' life.
153. Complete Reduction of Lymphedema Induced Adipose Tissue Hypertrophy in Elephantiasis of the Leg – a Prospective Study with a Ten-Year Follow-Up

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AIM

Patients with long-standing pronounced non-pitting lymphedema do not respond to conservative treatment or microsurgical procedures because slow or absent lymph flow, as well as chronic inflammation, cause the formation of excess subcutaneous adipose tissue, which cannot be removed by these methods. The swelling of chronic non-pitting arm lymphedema following breast cancer, can be completely reduced by liposuction and has not recurred during more than nineteen years' follow-up. Encouraged by this experience, we decided to test the effectiveness of liposuction on leg lymphedema.

METHODS

56 patients with an age of 52 years (range, 17-76) and a duration of leg swelling of 14 years (range, 2-50) underwent liposuction due to non-pitting, chronic lymphedema. There were 29 primary (PL), and 27 secondary lymphedemas (SL) following cancer therapy. Age at cancer treatment and interval between cancer treatment and lymphedema start were 43 years (range, 20-65), and 3 years (range, 0-26) respectively. Age at onset of PL was 32 years (range, 4-63). All patients had received conservative treatment before surgery without further reduction. All were wearing compression garments before surgery. Aspirate and leg volumes were recorded.

RESULTS

Aspirate volume was 3872 ml (range, 1210-8475) with an adipose tissue concentration of 94% (range, 61-100). Preoperative excess volume was 3935 ml (range, 1200-8475). Postoperative mean reduction was 83% (range, 22-135) at 3 months and 104% (range, 75-163) at 1 year, and more than 100% during 10 years' follow-up when it was 115% (range, 112-119), i.e. the lymphedematous leg was somewhat smaller than the healthy one (Figure 1 and 2).
The preoperative mean ratio between the volumes of the edematous and healthy legs was 1.4, rapidly declining to 1.0 at 1 year and less than 1 after one year.

**CONCLUSION**

Liposuction is an effective method for treatment of chronic, non-pitting leg lymphedema in patients who have failed conservative treatment. It is the only known method that completely reduces excess volume at all stages of lymphedema. The removal of hypertrophied adipose tissue...
is a prerequisite to complete reduction. The reduced volume is maintained through constant use of compression garments.
154. LYMPHA Significantly Decreases the Incidence of Upper Extremity Lymphedema After Axillary Lymph Node Dissection

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Introduction: LYMPHA (Lymphatic Microsurgical Preventive Healing Approach) is a technique for the prevention of upper extremity lymphedema that involves a simplified lympho-venous coaptation performed at the time of axillary lymph node dissection. Our group has previously published our preliminary series as a proof-of-concept study, and now aims to evaluate its effectiveness in preventing lymphedema by comparing the incidence of lymphedema in patients who have undergone LYMPHA and in those who have not.

Methods: The study included patients who underwent axillary lymph node dissection for the treatment of breast cancer, subsequently underwent immediate attempt at LYMPHA, and then had ≥12 months of post-operative follow-up. This group was subdivided into those in whom LYMPHA was successfully completed, and those in whom LYMPHA was attempted but not completed due to anatomic limitations. The primary endpoint was the onset of lymphedema, and whether the lymphedema was transient or persistent. Statistical analysis was performed using Student's t-test and Fischer's exact test, with statistical significance set at p<0.05.

Results: Thirty-nine patients met criteria for the study; LYMPHA was successfully completed in 30 patients (77%), and not able to be completed in 9 patients. The reasons LYMPHA was not able to be completed included the lack of a suitable lymphatic vessel (5 patients), the lack of a suitable vein (3 patients), and extensive axillary metastases (1 patient). The mean age and BMI of those with successful LYMPHA was 56.3 years and 28.4, respectively, and in those in whom LYMPHA was not completed was 54.6 years and 29.4, respectively (p=NS). At a mean follow-up of 25.9 months (range: 12-42 months), lymphedema had occurred in 10% of patients (transient in 1, persistent in 2) who had undergone successful LYMPHA, and in 44% of patients (transient in 2, persistent in 2) in whom LYMPHA was unsuccessful (p=0.022) (Figure).

Conclusion: Patients who underwent LYMPHA had a statistically significantly decreased incidence of upper extremity lymphedema. Given that this is the only reported technique that has been shown to reduce the incidence of lymphedema after axillary lymph node dissection, both further study and consideration of widespread adoption are warranted.
Upper extremity lymphedema

![Graph showing bar chart with percentages.]

- Control (no LYMPHA): 44%
- LYMPHA: 10%

p = 0.02
Guided Lymphangiogenesis for the Treatment of Lymphedema: a Pilot Study

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To address the limitations of current treatments for secondary lymphedema, our study group developed an experimental surgical procedure based on Autologous Lymph Node Fragment (ALNF) transfer supplemented by nanofibrillar collagen scaffold with and without autologous Adipose Derived Stromal Cells (ADSCs). The efficacy of this scaffold was demonstrated before by histological, functional and imaging analyses in a porcine model of secondary lymphedema. The use of ADSCs has major potential demonstrated in preclinical and clinical studies, but their use is often hampered due to difficulties in harvesting and delivery. The cell injections require large dosages and still have limited effect due to poor survival and migration from the target site. We address these challenges by using ADSC-seeded scaffolds to deliver the cells, support cell survival, maintenance and function precisely at the targeted site. The ongoing pilot study has 8 patients currently enrolled. The ALNF transfer was performed in all patients and additionally 6 patients received the collagen scaffolds alone and 2 patients received the ADSC-seeded scaffolds. Lymphoscintigraphy was conducted before the treatment and will be conducted at the end of the study, 12 months after the initial surgery. Volume and bioimpedance measurements (L-Dex U400) were scheduled for 0, 3, 5, 8 and 12 months after surgery. A portable closed-loop Mini-Stem system was used for extraction of ADSCs from patient lipoaspirate. Also, a 1.7 ml trocar was used for cell seeding on the scaffolds (~2 hours in incubator) and for subcutaneous delivery to bridge the area of impaired lymphatics. While this is a small ongoing study, safety has been demonstrated as there has been no complications reported over the first nine months. For the first set of patients (n = 3), the affected/unaffected limb volume ratio was reduced on average from 1.49 to 1.33 at 8 months after surgery. For two patients in the second set (n = 5), the affected/unaffected limb volume ratio was reduced from 1.23 to 1.1 at 3 months after surgery. More preliminary data will be presented at the time of the conference. While vascularized lymph node transfer is considered to be a more advanced technique than ALNF transfer, there is a great interest in developing countries to have a simpler surgery that could help patients with lymphedema. On the other hand, if the current treatment improves lymphedema, the concept of guiding lymphangiogenesis with collagen scaffolds could potentially improve the efficiency of established vascularized lymph node procedures.
Introduction: Scrotum lymphedema is endemic on a global level and challenging to plastic surgeons. Treatments are radical and destructive, and very few advanced treatments present because of the insufficiency of related researches. We describe the first animal model of scrotal lymphedema using Cre-Lox P system and subsequently applied the novel model for topical treatment of scrotum lymphedema using Tacrolimus.

Methods: We created Cre-loxP mice that express the human diphtheria toxin receptor selectively on lymphatic endothelial cells (LECs) using a lymphatic specific promoter (FLT-4). This receptor binds diphtheria toxin (DT) avidly and results in selective ablation of the target cells. Following with injection of DT, selective scrotum lymphedema was created successfully. After successful animal model development, we applied topical tacrolimus onto the scrotum skin immediately after lymphatic ablation using DT injection as a preventive treatment.

Results: Over the course of one week, scrotal volumes increased of 519.6% and sustained till the end of the study. Immunofluorescent staining of the scrotum skin revealed a 66% reduction in dermal capillary lymphatic vessel density, 125% increase in T cell soft tissue infiltration (p=0.042). There was also significant increase of epidermis and dermis thickness after DT injection, representing hyperkeratosis. With preventive treatment, the increase of scrotum volume as well as histological features regarding lymphatic vessel density, hyperkeratosis, increased T-cell and macrophage infiltration, sclerotic change of collecting lymphatic vessels were successfully prevented.

Conclusions: An animal model of scrotal lymphedema was successfully created. Furthermore, we applied it for pharmaceutical treatment using topical tacrolimus with promising results. Further experiments using this model may allow for new discoveries of scrotal lymphatic function/dysfunction and development of surgical as well as pharmacological treatments.
Breast Reconstruction is Associated with Lower Rates of Lymphedema in Patients Surgically Treated for Breast Cancer: a Systematic Review of Observational Studies and Meta-Analysis

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Introduction: Lymphedema remains a significant complication of breast cancer surgery. Previous systematic reviews have identified risk factors for breast cancer-related lymphedema, including BMI, number of lymph nodes dissected. However, they have not examined the effect of breast reconstruction (BR) on lymphedema occurrence. In this systematic review and meta-analysis we estimated the association between BR and lymphedema.

Materials and Methods: We searched PubMed (1966-2016), Embase (1966-2016), Scopus (2004-2016) and Google Scholar (2004-2016) for studies involving BR and upper-extremity lymphedema or breast cancer-related lymphedema through April 8, 2016. Our primary outcome was lymphedema occurrence. We performed a meta-analysis using random effects due to heterogeneity of the studies.

Results: Our search strategy identified 853 articles, 18 studies were included in our meta-analysis evaluating outcomes based on number of patients (6,885) or number of breasts surgically treated (2,063). BR was significantly associated with lower odds of lymphedema (p<0.001) compared to mastectomy only or breast-conserving surgery. Lymphedema rates were not significantly different between patients undergoing implant-based or autologous BR.

Conclusions: BR patients experience lower rates of lymphedema compared to mastectomy only or breast conserving surgery patients. This is likely due to multiple factors, including a self-selecting population and mechanisms through which BR may contribute to primary or secondary prevention of lymphedema. Further prospective research is needed to clarify whether a potential beneficial relationship exists between BR and reduced lymphedema risk.
Forest Plot for 15 studies reporting Lymphedema Odds between patients with breast reconstruction and without
Forest plot for one study reporting outcomes based on the number of mastectomies for the comparison of Lymphedema Odds between mastectomy + breast reconstruction and mastectomy only surgery.

Forest plot for the 3 studies reporting Lymphedema Odds in patients with Implant and autologous breast reconstruction.

Forest plot for the 2 studies reporting Lymphedema Odds in breasts receiving implant or autologous breast reconstruction.